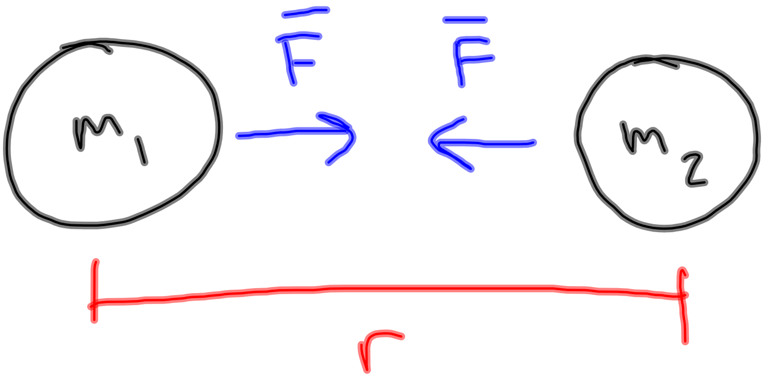
Newton's Law of Universal Gravitation:

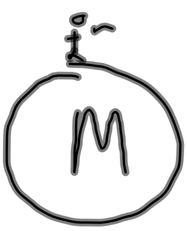


$$F = \frac{G m_1 m_2}{r^2}$$

$G = 6.67E-11$

$N \cdot m^2/kg^2$

Finding a_g (g):



$$\cancel{m} g = \frac{G \cancel{m} M}{R}$$

$$g = \frac{GM}{R}$$

Newton's Law of Universal Graviation and Kepler's Laws 10.31.11 AP Physics

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
diameter (Earth=1)	0.382	0.949	1	0.532	11.209	9.44	4.007	3.883
diameter (km)	4,878	12,104	12,756	6,787	142,800	120,000	51,118	49,528
mass (Earth=1)	0.055	0.815	1	0.107	318	95	15	17
mean distance from Sun (AU)	0.39	0.72	1	1.52	5.2	9.54	19.18	30.06
orbital period (Earth years)	0.24	0.62	1	1.88	11.86	29.46	84.01	164.8
orbital eccentricity	0.2056	0.007	0.017	0.093	0.0483	0.056	0.0461	0.0097
mean orbital velocity (km/sec)	47.89	35.03	29.79	24.13	13.06	9.64	6.81	5.43
rotation period (in Earth days)	58.65	-243*	1	1.03	0.41	0.44	-0.72*	0.72

* indicates planet rotates opposite direction to that which in orbits the Sun

Source: http://www.windows.ucar.edu/tour/link=/our_solar_system/planets_table.html

Find g on the moon.
Mass of the moon = 7.35E22 kg
Radius of the moon = 1.74E6 m

$$g_m = \frac{G M_m}{R_m^2}$$

$$= \frac{(6.67E{-11}\ N\cdot m^2/kg^2)(7.35E22\ kg)}{(1.74E6\ m)}$$

$$= 1.62\ m/s^2$$

Newton's Law of Universal Graviation and Kepler's Laws 10.31.11 AP Physics

Find g on a planet that has the same mass as Earth but 2.5 times the radius.

$$g_{planet} = \frac{GM_E}{R_{planet}^2} \qquad R_{planet} = 2.5R_E$$

$$= \frac{GM_E}{(2.5R_E)^2}$$

$$= \frac{1}{6.25}\boxed{\frac{GM_E}{R_E^2}} = g_E$$

$$= \frac{1}{6.25} g_E$$

Find g on a planet that has double the mass of Earth and twice the radius.

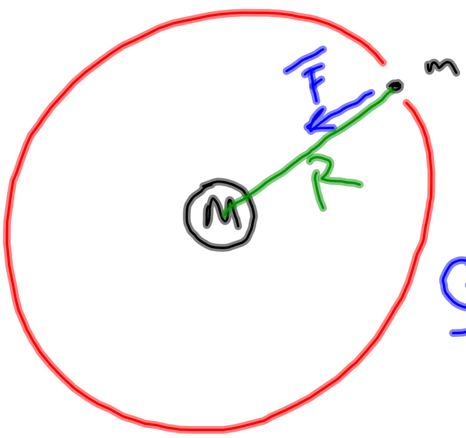
$$g_p = \frac{GM_p}{R_p^2} \qquad M_p = 2M_E$$

$$R_p = 2M_R$$

$$= \frac{G(2M_E)}{(2R_E)^2}$$

$$= \frac{2}{4}\boxed{\frac{GM_E}{R_E^2}} = g_E$$

$$= \frac{1}{2} g_E$$



$$\sum \bar{F} = m\bar{a}_c$$

$$\frac{G\cancel{m}M}{R^{\cancel{2}}} = \cancel{m}\frac{v^2}{\cancel{R}}$$

$$V = \sqrt{\frac{GM}{R}}$$

How much would the orbital radius have to be increased to halve the orbital speed?

$$V = \sqrt{\frac{GM}{R}}$$

either $\frac{1}{4}M$ or $4R$

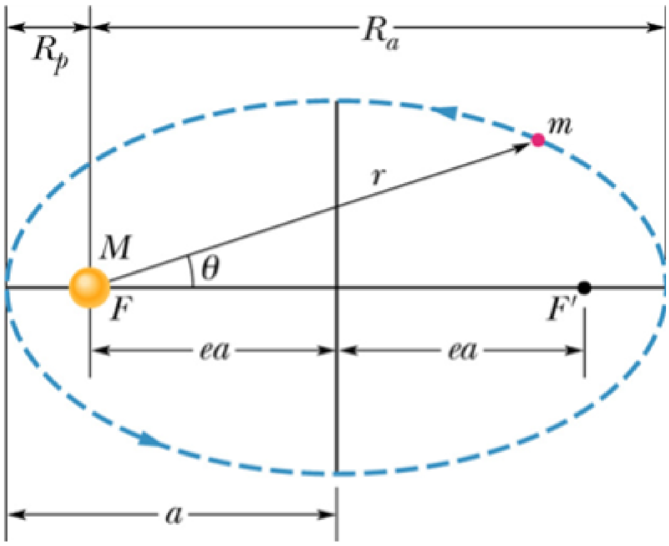
How much would the mass of the planet have to be increased to double the orbital speed?

$$V = \sqrt{\frac{GM}{R}}$$

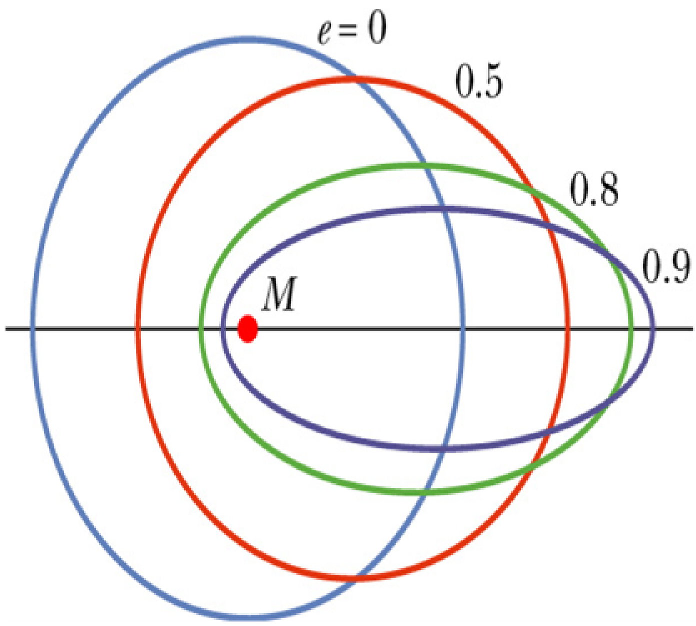
for $2v$, either $4M$ or $\frac{1}{4}R$

Kepler's 1st Law:

- All planets move in elliptical orbits, with the Sun at one focus

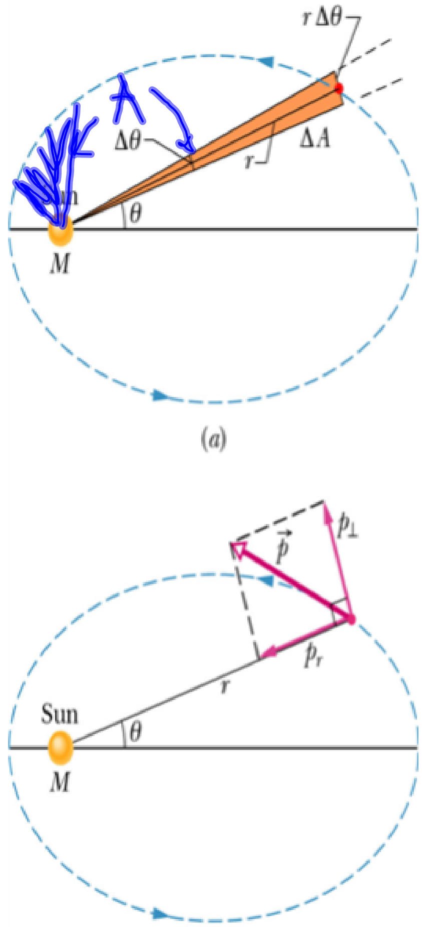


Eccentricity



Kepler's 2nd Law:

- Law of areas
- Angular momentum is the same at all times



(a)

(b)

Kepler's 3rd Law:

- Law of periods

$$T^2 = \left(\frac{4\pi^2}{GM}\right) a^3$$

a is radius from focus

M is mass of object at focus

How high is a geosynchronous orbit?

$T = 1$ day

What the velocity?

$R_E = 6.37E6$ m

$M_E = 5.97E24$ kg